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Study on Comfort Characteristics of Three Layered Technical Textiles for Sportswear

Hari Gopalakrishnan[1], Dr T Ramachandran[2]
[1]Research Scholar, Department of Textile Technology,
[2]Principal, Karpagam Institute of Technology, Coimbatore, India.

Abstract: *Conventional fabrics, in general had limitations in fulfilling the comfort characteristics of a sportswear; hence an attempt has been made and developed a three layered fabrics, which possess enhanced comfort characteristics suitable for the sportswear. The Wickability, Air Permeability, Water Vapour Permeability, Thermal Conductivity and Thermal Resistance characteristics which influences the comfort characteristics have been tested and critically analysed.. Three layered fabrics were developed using the three different warp layers such as Lyocell as Inner layer, Cotton as middle layer and Polyester as outer layer and three varieties of three layered fabrics were developed by using cotton, polyester and Elastane as weft materials and keeping warp layers same for all the fabrics. These developed three varieties of the three layered fabrics were coded and their comfort characteristics were tested and analysed in details.*

Keywords: *Comfort characteristics, three layered fabrics, Lyocell, Elastane, Wickability, Air Permeability*

1. INTRODUCTION

The conventional fabrics, in general has a single layer, which has limitations in fulfilling the comfort characteristics of a sportswear such as Wickability, air permeability , Water Vapour Permeability, Thermal Conductivity and Thermal Resistance. Hence there is a need for a special fabric, to enhance the comfort characteristics of a sportswear. An attempt is made to develop a three layered fabric using three different kinds of materials to enhance the comfort characteristics of a sportswear. The improvements in comfort characteristics of the three layered fabrics have been analysed in detail.

2. Materials and Methods

For the development of Three layered Fabrics, three different varieties of warp materials were selected for three different layers such as Micro fibre Lyocell spun yarn for the Inner layer due to its better comfort characteristics, Cotton for the Middle layer due to its swelling characteristics to transport of sweat and perspiration and Micro fibre Polyester spun yarn for the Outer layer due to its protecting characteristics from the environmental conditions. The Three Weft materials such as Cotton, Polyester micro fibre spun yarn and Elastane Core spun yarn were selected for the development of three varieties of Three-Layered Fabrics. The three layered fabrics were successfully developed in the Rapier Loom. The details of materials selected, weave structure and fabric codes of developed fabrics were described in Table 1.

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Table 1-Details of Materials Used & Fabric Codes

S No	Layer	Warp	Weft	Ends/cm	Picks/cm	GSM	Weave Structure	Fabric Codes
1	Inner	Lyocell	Cotton	72	36	120	Backed & 2/3 Satin	C-01
	Middle	Cotton						
	Outer	Polyester						
2	Inner	Lyocell	Micro Fibre Polyester Spun Yarn	72	36	120	Backed & 2/3 Satin	P-01
	Middle	Cotton						
	Outer	Polyester						
3	Inner	Lyocell	Elastane Core Spun Yarn	72	36	120	Backed & 2/3 Satin	E-01
	Middle	Cotton						
	Outer	Polyester						

The Three developed three layered fabric samples were coded as above and the samples were analysed for comfort characteristics such as Wickability, Air Permeability, Water Vapour Permeability, Thermal Conductivity and Thermal Resistance.

Table 2 shows the Standards adopted for the various tests conducted for the developed fabric samples.

Table 2-Testing Methodology

S No	Characteristics	Standards for Testing Methodology
1	Wickability	AATCC 198-2011 Horizontal-Weft Way
		AATCC 197-2011 Vertical- Warp Way
2	Air Permeability	ISO 9237
3	Water Vapour Permeability	ASTM E96
4	Thermal Conductivity	ASTM D 1518 (2000)
5	Thermal Resistance	ASTM D 1518 (2000)

All the above tests were carried out, after conditioning the samples as per ASTM D 1776 standard.

3. Results and Discussions

The three varieties of developed three layered fabric samples were tested for comfort characteristics such as Wickability, Air Permeability, Water Vapour Permeability, Thermal Conductivity and Thermal Resistance. Quality analyses of three layered fabrics are described below.

3.1 Wickability

Fig 1 shows the Wickability of three different fabric samples in warp & weft directions for the test length of 1cm, 2cm, 3cm, 4cm & 5cm for the for the fabric codes of C-01, P-01 & E-01.

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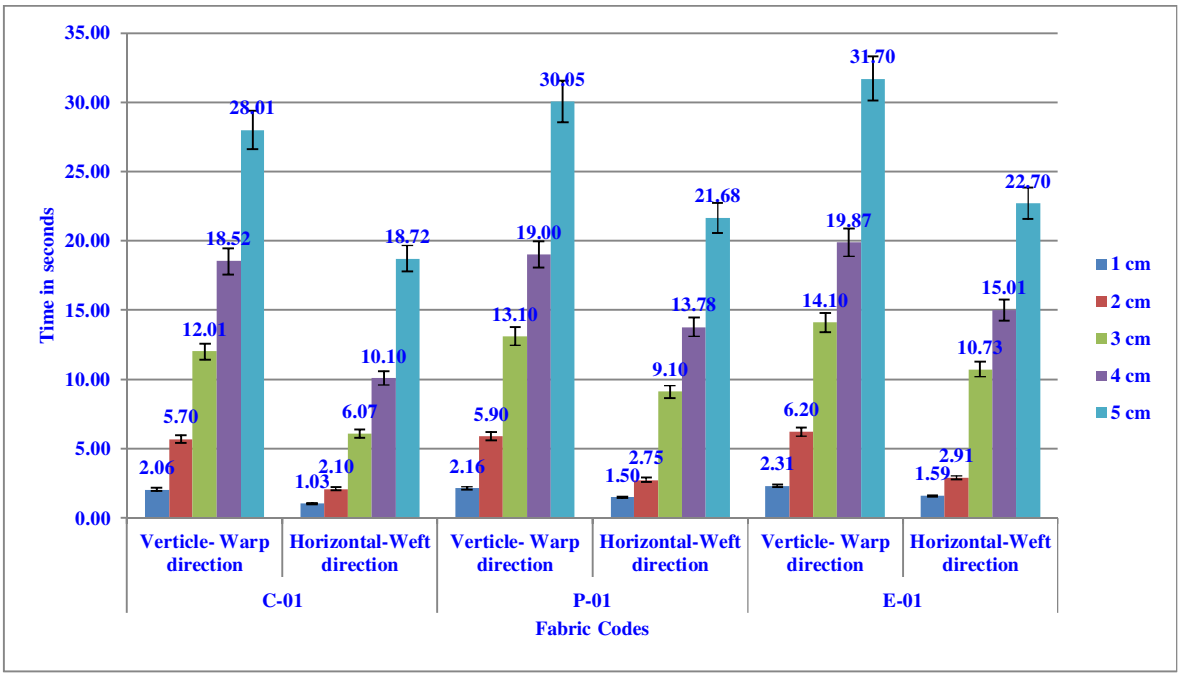

Fig 1- Wickability of Three Layered Fabric Samples

From the figure above, the wickability of fabric code C 01 was observed as 28.01 sec in warp direction and 18.72 sec in weft direction for the test length of 5cm. For the fabric code, P-01, the wickability was found as 30.05sec & 21.68 sec; for the fabric code, E-01, the wickability was found as 31.7 sec and 22.7 sec for warp & weft direction respectively for the test length of 5cm. The Anova test proved that the Wickability values were statistically significant.

3.2 Air Permeability

Fig 2 shows the Air Permeability of three developed three layered fabric samples coded as C-01, P-01 & E-01. The Air Permeability values were found as 96 for fabric code C-01, 90 for fabric code P-01 and 87 for fabric code E-01. The Air permeability data were analysed using Anova and found that the differences in values were quite significant.

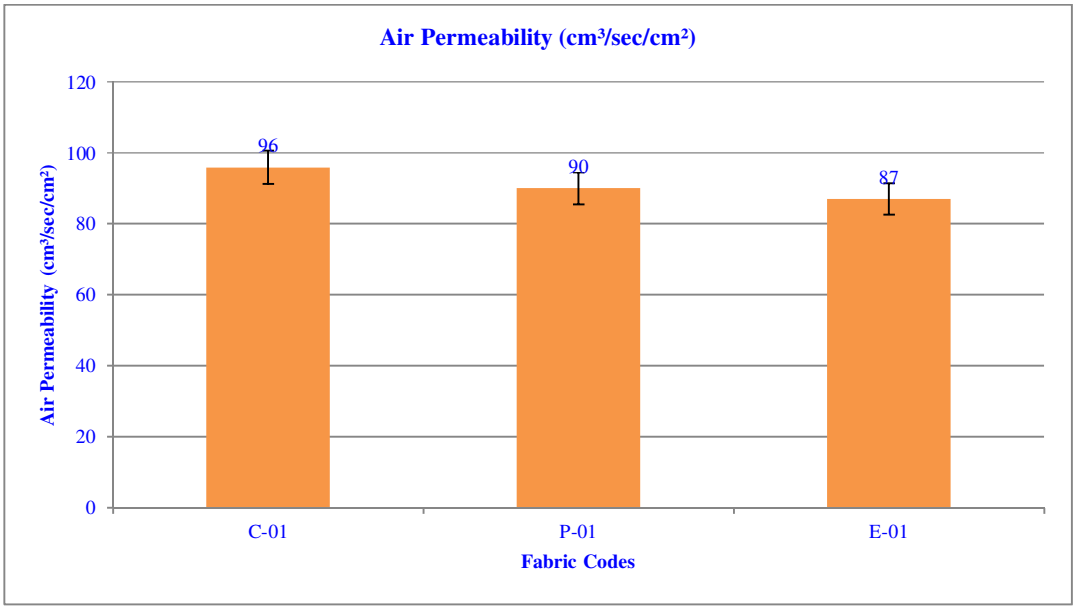

Fig 2- Air Permeability of Three Layered Fabric Samples

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The fabric code C-01 showed better Air Permeability than fabric codes of P-01 and E-01. The cover of the fabric codes P-01 and E-01 was higher due to bulkiness of Polyester component used in fabric code P-01 and shrinkage of Elastane component used in fabric code E-01, which resulted into lower Air Permeability.

3.3 Water Vapour Permeability

The Water Vapour Permeability was found as per details shown in Table 3 for the fabric codes of C-01, P-01 & E-01.

Table 3- Water Vapour Permeability

Fabric Code	Weight (Before test)	Weight (After test)	Loss of Mass in grams	Water Vapour Permeability
	M1 gm	M2 gm	M=M1-M2	gm/m²/day
C-01	20	116.3	3.7	3196.8
P-01	120	116.8	3.2	2764.8
E-01	120	117.1	2.9	2505.6

The fabric code C-01, which has cotton as weft had higher Water Vapour Permeability by 28% than fabric codes of P-01 & 10% than E-01, which has Polyester and Elastane as weft yarn respectively. Cotton being a natural cellulose material which has better moisture properties transported more water vapour than synthetic spun yarns of Polyester and Elastane.

3.4 Thermal Conductivity and Thermal Resistance

In physics, the thermal conductivity is the property of material's ability to conduct heat. Thermal conductivity is measured in watts per kelvin-meter. The reciprocal of thermal conductivity is Thermal Resistivity. Fig 3 shows the Thermal Conductivity and Thermal Resistance of developed three layered fabric samples. The Thermal Conductivity and Thermal Resistance values were analysed using Anova and found that they were statistically significant.

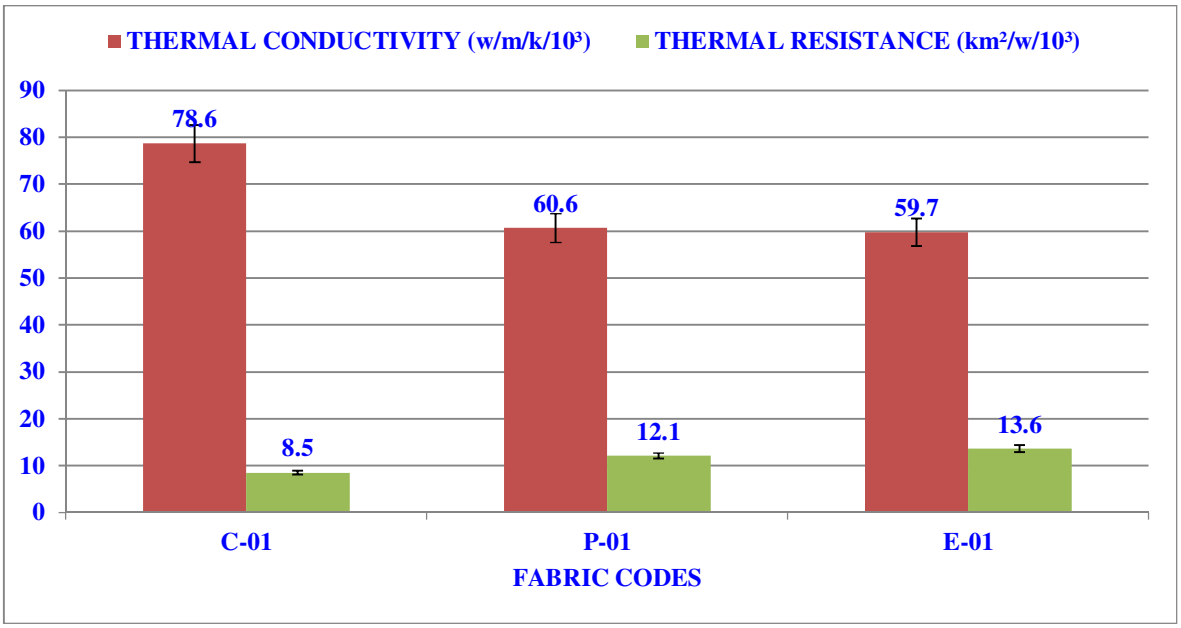

Fig 3- Thermal Conductivity and Thermal Resistance of Three Layered Fabric Samples

The fabric coded as C-01 showed Thermal Conductivity of 78.6 and Thermal Resistivity of 8.5. The fabric code P-01 had Thermal Conductivity and Thermal Resistivity values as 60.6 & 12.1 and fabric code of E-01 had values of 59.7 & 13.6 respectively. The fabric code C-01 had better Thermal Conductivity and the least Thermal Resistance than other fabric codes such as P-01 & E-01. As Cotton having better moisture properties displayed better Thermal Conductivity and obviously the least Thermal Resistance. The synthetic

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fibres of Polyester and Elastane displayed relatively lower Thermal Conductivity due to their relatively poor moisture properties than cotton.

4. Conclusion

Three layered Fabrics were developed using three different varieties of warp materials such as Micro fibre Lyocell spun yarn for the Inner layer due to its better comfort characteristics, Cotton for the Middle layer due to its swelling characteristics to transport of sweat and perspiration and Micro fibre Polyester spun yarn for the Outer layer due to its protecting characteristics from the environmental conditions. The Three Weft materials such as Cotton, Polyester micro fibre spun yarn and Elastane Core spun yarn were used for the three varieties of Three-Layered Fabrics. Their comfort characteristics such as Wickability, Air Permeability, Water Vapour Permeability, Thermal Conductivity and Thermal Resistance were tested as per AATCC, ISO & ASTM standard of testing and analysed their comfort characteristics. It was found that the three layered fabrics having cotton as weft had better Wickability by 11.6%, Air Permeability by 9.4%, Water Vapour Permeability by 21.6% and Thermal Conductivity by 24% than other fabrics having Polyester and Elastane as weft yarn and the differences were statistically significant. Cotton as weft had the least Thermal Resistance by 37.5% than the other two fabrics.

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